

1.0 INTRODUCTION

The Conceptual Model for Mercury in the Guadalupe River Watershed describes our understanding of the biogeochemical processes controlling mercury transport and fate in the watershed and identifies additional data that are needed for the development of the TMDL (Total Maximum Daily Loads) Technical Report and the Implementation Plan. Three important roles are ascribed to the conceptual model: data synthesis, communication, and project planning.

The conceptual model is the third of five products being developed in Phase 1 of the TMDL for Mercury in the Guadalupe River Watershed (Tetra Tech, 2003a). The other four products are:

- **Preliminary Problem Statement.** *Technical Memorandum 1.2 Preliminary Problem Statement* (Tetra Tech, 2003b) describes the current understanding of the processes or factors that are most relevant to controlling mercury in the watershed.
- **Synoptic Survey.** *Technical Memorandum 2.1.2 Synoptic Survey Plan* (Tetra Tech, 2003c) and *Technical Memorandum 2.2 Synoptic Survey Report* (Tetra Tech, 2003d) describe the preliminary field sampling effort designed to provide an overview of mercury contamination in the watershed. This survey was conducted in July and August 2003, and the results have been incorporated into the development of the conceptual model.
- **Data Collection Plan.** Based on the conceptual model, the data collection plan identifies the minimum additional data needed to develop a defensible TMDL and Implementation Plan. The data collection plan will identify the data required to reduce uncertainty associated with key aspects of the TMDL, e.g., 1) the relative importance of individual processes to the transport and fate of mercury in the watershed, 2) estimated magnitudes of mercury loads from different sources, and 3) the effectiveness of alternative control measures.

- **Data Collection Report.** The results of the data collection task will be summarized in a report that describes how these data reduce uncertainty and increase our knowledge of the estimates of mercury loads and the significance of processes controlling mercury methylation. The Data Collection Report will also describe the use of this information in the preparation of the TMDL and Implementation Plan.

The development of conceptual models was one of the primary recommendations of the National Research Council (NRC) in its assessment of the scientific basis of the TMDL approach to Water Quality Management (NRC, 2001). Conceptual models provide an explicit description of our understanding of the relationships among important environmental variables. The use of conceptual models was recommended to describe the link between environmental stressors (as well as control actions) and environmental responses. The NRC recommendation for building conceptual models was also made with the recognition of the “inevitable limits on our conceptual understanding of these complex natural systems” and with the warning that the science behind water quality management must be utilized with an acknowledgement of uncertainties that exist.

In complex natural systems, there are many vantage points from which to view and describe the relationships among the important physical, water quality, and biological variables that define the behavior of mercury in the watershed system. The challenge is to identify the most important variables and processes without creating a complex abstraction that, while definable and defensible, does not provide practical guidance that is relevant to the regulatory decision-making process. On the other hand, an oversimplification of the system is of limited value if it does not provide a meaningful representation of the system that is appropriate for designing regulatory actions.

1.1 ROLE OF THE CONCEPTUAL MODEL IN THE DEVELOPMENT OF THE MERCURY TMDL

It is with the recognition of the need to provide a scientific basis for the TMDL and with the acknowledgment of the uncertainties associated with model development that three main goals were identified for the Mercury Conceptual Model for the Guadalupe River Watershed (the mercury conceptual model): data synthesis, communication, and project planning.

1.1.1 DATA SYNTHESIS

The mercury conceptual model provides a synthesis of existing information. Mercury sources, loadings, mercury inventories within the system, and tissue levels within biota are summarized. Water quality, physical data, and significant system characteristics are summarized to describe the variables that affect mercury behavior in the watershed. The existing data include historical data that have been collected over the past several decades as well as the results of the recently conducted synoptic

survey (Tetra Tech, 2003d), which provides an up-to-date overview of mercury contamination in the watershed.

The processes affecting mercury behavior in creeks, reservoirs, and river systems in general are identified, and their roles in individual waterbodies within the watershed are described. Emphasis is also placed on the importance of the hydrologic connectivity within the watershed. For although there are five waterbodies within the watershed listed as impaired due to the presence of mercury (Calero Reservoir, Guadalupe Reservoir, Alamitos Creek, Guadalupe Creek, and Guadalupe River), it is believed that mercury concerns in these waterbodies can most efficiently be addressed by undertaking a single TMDL project that concurrently considers all mercury sources in the Watershed (RWQCB, 2003a). The Guadalupe River Watershed Mercury TMDL is also viewed as the primary regulatory vehicle for reducing mercury loads to San Francisco Bay (RWQCB, 2003b).

1.1.2 COMMUNICATION

This report makes extensive use of graphics to communicate the information that has been developed on the extent of mercury in the watershed (sources) and how mercury behaves (i.e., fate, transport, and bioaccumulation). Graphic tools have been prepared for effectively communicating the existing information to a wide audience of interested stakeholders. It is intended that the diagrams presented in this document can be used throughout this project to facilitate the discussion of important issues and individual elements of the TMDL.

1.1.3 PROJECT PLANNING

By explicitly identifying the important processes that control mercury cycling and summarizing our understanding of these processes, the conceptual model provides a technical basis for TMDL project planning. The information presented in this report will be used to guide the scope and direction of the other tasks, as well as the overall technical approach for the development of the TMDL.

The mercury conceptual model extends the description of our knowledge of existing conditions and the processes affecting the existing conditions. The first attempt is made at quantifying the linkage between mercury sources, loadings between different segments of the system, and bioaccumulation. The system is divided into five groups of water bodies: 1) reservoirs, 2) streams and creeks in the upper watershed (above Ross Creek) draining the historic mercury mine areas, 3) creeks in the upper watershed draining areas not known to contain mines, 4) Guadalupe River downstream of Almaden Lake to St. Johns Street and 5) Guadalupe River from St. Johns Street to Alviso Slough. For each segment, quantitative estimates are made of the mercury sources and concentrations within water, sediment, and fish tissue. These analyses are used to identify additional data needed to develop the TMDL. A series of testable hypotheses are developed, and data collection strategies are described to address these hypotheses and to reduce uncertainty associated with conclusions based on existing data.

1.2 GUIDE TO THE CONCEPTUAL MODEL – REPORT ORGANIZATION

In addition to this introduction, the Conceptual Model Report is organized into six chapters:

2.0 Watershed Characterization and Description of Mercury Sources

Much of the information presented in the Conceptual Model assumes a fundamental understanding of the watershed characteristics (topography, geology, meteorology, and hydrology) and historical mercury mining operations in the watershed. The reader familiar with this information may choose to skip this section. However, existing information on recent mercury measurements in the watershed, including the results of the recently completed Synoptic Survey (Tetra Tech, 2003d), and fish bioaccumulation data are also summarized in this section.

3.0 Summary of the Synoptic Survey Results – An Initial Step in Conceptual Model Development

A side-by-side comparison of Lexington, Almaden, Guadalupe, and Calero Reservoirs, and their downstream creeks, provides insight into the behavior of mercury in the Guadalupe River Watershed. This presentation serves as a starting point for the development of the Conceptual Model.

4.0 Conceptual Model of Mercury Behavior in the Guadalupe River Watershed

The important processes affecting mercury behavior in creeks, reservoirs, and the Guadalupe river are summarized in a series of diagrams. The accompanying descriptions summarize the current understanding of mercury behavior in the watershed. These descriptions are summarized in a series of hypotheses that identify the essential information needed to develop a defensible TMDL and Implementation Plan.

5.0 Preliminary Source and Loading Estimates

Preliminary source descriptions and mercury loading estimates are presented for dry and wet seasons. Using historical streamflow data from 1950 to 2001, annual total mercury loads for the Guadalupe River are estimated. This exercise provides another indication of where additional data are needed to prepare the mercury TMDL.

6.0 Summary and Strategy for Developing the Data Collection Plan

The findings of the Conceptual Model Report are summarized, and the use of this information to develop the data collection plans is discussed.

7.0 References

The references cited in all chapters of this report are presented at the end of the report in Chapter 7.0.